

Deep squatting: Good or Bad?

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Deep squatting is one the most controversial exercises performed by many athletes, weight lifters, and individuals requiring rehabilitation following lower extremity and lumbar injuries. Some consider deep squats to be an ideal exercise as they involve multi-joint movement into end-range along with the activation of large muscle groups (Palmitier et al 1991, Schoenfeld et al 2010), while others consider it an absolute contra-indication for anyone with hip and knee osteoarthritis (OA) or injury (Neitsel et al 2000, Liu et al 2007, Amin et al 2010).



The aim of this article is not to debate the pros and cons of loaded squats as performed by power lifters, as there are hundreds of papers already on that topic and they are mostly irrelevant to a typical patient population seen by physical therapists. The focus of this paper is to present the available evidence and discuss the potential value of the **unloaded deep squat**, defined as a resting posture of maximum hip and knee flexion where the posterior thighs are in contact with the calves and the heels remain flat on the floor. This posture is also referred to as the öAsian squatö or öthird-world squatö (these terms seem politically incorrect so I shall not use them).



A study on Buddhist monks in Thailand concluded that a lifetime of floor activities such as squatting, lotus and kneeling was not a risk factor to the development of knee OA (Tangtrakulwanich et al 2006).



A Chinese study also found that occasional squatting actually decreased the risk of knee OA development (Lin et al 2010).

“... there is scant evidence to show that deep squats are contraindicated in those with healthy knee function.” ö (Schoenfeld 2010)

“...squatting decreased the risk of radiographic tibiofemoral, lateral compartment, and medial compartment knee OA.” (Lin et al 2010)

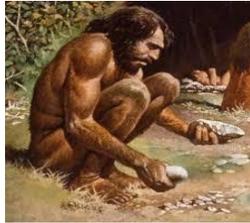
“Contrary to commonly voiced concern, deep squats do not contribute increased risk of injury to passive tissues.” (Hartmann et al 2013)

On the other hand, some studies have shown deep squatting for longer than 30 minutes a day to be a risk factor for knee OA and patella-femoral degeneration (Dahaghin et al 2009, Coggon et al 2000, Amin et al 2008). Two large retrospective studies also found that prolonged sustained deep squatting (several hours a day) was a strong risk factor for knee OA among the elderly Chinese population (Zhang et al 2004, Liu et al 2007). However before we judge deep squatting as terrible and never prescribe it to patients again, consider who, in our modern world, really squats for longer than 30 minutes a day?

I don't have any stats on this, but I believe the far majority of adults in the western world NEVER go into a deep squat position. Not even for a minute a day, a month or a year. A typical North American adult sits the majority of the day with their hips flexed to 90°, drives to work with their hips flexed to 80°, stands, and walks and then goes to bed. Basically not once taking their hips and knees past 90°.



In contrast, for millions of years, all of our ancestors used to squat on a daily basis. Primates bearing the greatest genetic similarities to us and being our closest cousins (Vallender 2013) were squatting for millions of years before us and continue to squat.



In fact the majority of the population in Asia and Africa continue to squat on a daily basis, primarily for toileting purposes or for various activities of daily living such as eating, doing laundry or simply resting (Mulholland et al 2001).



Children often rest in a deep squat freely and comfortably, but something happens along the way where we no longer find squatting functional. Sustaining a deep squat for several minutes is an elementary component of human movement but sadly the majority of adults in the Western world grow out of it and are unable to do this fundamental task. **So what's the big deal if we no longer squat?**



The hip, knee and ankle are all synovial joints containing synovial fluid and hyaluronic acid which are essential for cartilage health. The purpose of this viscous fluid is to reduce friction, absorb shock, and transport nutrients to the hyaline cartilage which are otherwise avascular (Clinically Oriented Anatomy textbook). The word "synovial" partially derives from "ovum" which is Latin for egg, in order to describe the

fluid for its egg-like consistency. Synovial fluid has an amazingly rare chemical property of becoming **more viscous** under applied pressure and shear forces, in order to protect the joint (Hlavacek et al 2001).



Synovial fluid forms a very thin layer at the surface of cartilage and seeps into micro-cavities in the cartilage surface, filling all the empty spaces where it serves as a synovial fluid reserve. All synovial joints require two fundamental things in order to maintain cartilage health, (i) movement (ii) compression (Nguyen et al 2010, Grodzinsky et al 2000). By means of movement and compression, the synovial fluid held in the cartilage is squeezed out mechanically to maintain a layer of fluid on the cartilage surface. Joint immobilization has certainly been shown to decrease synovial fluid, hyaluronic acid concentrations and reduce articular cartilage health (Pitsillides et al 1999, Nguyen et al 2010).

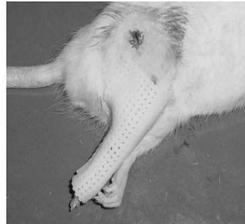
Contradicting a common belief among the general population, a systematic review concludes that moderate physical activities involving loading of joints is not associated with joint space narrowing but with **increased cartilage volume** (Urquhart et al 2011) and the most recent Cochrane database systematic review concludes that physical exercise is beneficial for individuals with knee OA (Fransen et al 2015). At the end of a deep squat, the knee flexes up to 150° and the tibiofemoral joint forces are as high as 4 times the body weight (Thambyah et al 2008). I cannot think of a more efficient and effective method of moving and briefly loading the hip, knee and ankle joints.



I go by the philosophy, **"use it or lose it"**. If we do not flex our hips and knees past 90° for years, then the joints say, *"Heck, I'm not being used anyways in my terminal 40°, I might as well degenerate."*

Mechanical cues resulting from joint loading and tissue deformation modulate chondrocyte and cartilage metabolism. (Nguyen et al 2010)

Healthy synovial fluid and adequate hyaluronic acid concentrations within a joint are critical as studies have shown that even small increases in friction are capable of causing damage to cartilage surfaces (Jay et al 2007). Some animal studies (rats) show that following a short course of immobilization, it is possible to regain articular cartilage health (Kunz et al 2014), yet another animal study showed that re-mobilization after prolonged immobility, may gain back range of motion but the damage to the articular cartilage and synovial membrane may be irreversible (Kojima et al 2014). Basically as time goes on, immobilized synovial joints adapt to not creating synovial fluid, consequently they may either never become normal again or they may require a lot more movement and compression to get the synovial fluid flowing again.



Basically prevention is better than cure. If you are able to go into and comfortably hold a deep squat position and return back up with ease, good on you- keep on doing it on a daily basis. Preventing loss of mobility is always easier than regaining mobility once it has been lost. Squatting on a daily basis should not be optional, but should be considered an essential human posture for maintaining lower extremity joint and muscular health.

Since ankle dorsiflexion and hip flexion ROM are directly associated with squat depth (Kim et al 2015), daily deep squats may help improve hip and ankle mobility as end-range over-pressure is applied naturally by the patient's own body weight. Ideally the squat should be as deep as possible as the maximum angles of the hips and knees are reached simultaneously at the bottom of the squat (McKean et al 2010).

Greater squat depth has also been shown to increase the activation of the gluteus maximus muscle (Caterisano et al 2002) therefore getting

in and out of a deep squat may be an effective way of strengthening the gluteal muscles.

Appreciating the fact that PTs can be hesitant about prescribing deep squats to seniors, a study on older adults showed that a chair squat can still produce significant contractions of the hip extensors, knee extensors and plantar flexors (Flanagan et al 2003). Just body weight half squats have been shown to be an effective strengthening exercise (Takai et al 2013).

Certainly the load on the knees do increase with greater squat depths, interestingly at the end-range of a deep squat or at the point of thigh-calf contact, tibiofemoral compressive forces, shear forces, and patellar tendon forces have all been shown to actually **decrease** (Zelle et al 2009).

Application of Squats into Clinical Practice

If a patient cannot get into an unsupported deep squat position because of pain, lack of mobility, muscle weakness or poor balance, don't give up; modify it.



Level 1: Chair supported squats are ideal for seniors or those unable to go deep. One set of 5-10 repetitions twice a day is the ideal minimum.

Level 2: Hand supported deep squats are ideal for those who are unable to do it unsupported without falling backwards. This is often due to insufficient ankle dorsi-flexion mobility and is the most common squat I prescribe. I prescribe 3-10 repetitions once a day for maintenance or three times a day for rehab purposes.

Level 3a: Unsupported deep squats are ideal for those who can do it. This is a great exercise when focus is on mobilizing the hips and knees. Do 3-10 repetitions once a day for maintenance or three times a day for rehab purposes.

Level 3b: Wall supported deep squats are ideal for those who are yet unable to squat deeply without falling backwards. This is a great exercise when focus is on strengthening. Three sets of 5-10 repetitions once a day is ideal and it will give the quads and hams a good burn!

Fully appreciating the variations in our bodies, not everyone is expected to squat the same way. I don't particularly instruct patients to keep their feet facing directly forward and exactly shoulder width apart. I don't instruct on keeping their back perfectly straight and maintaining the knees behind the toes. My only instruction is, *"Can you go into a deep squat as far as you can comfortably go, keep your heels on the ground and try not to fall backwards. You know you are good when you can take your knees into your armpits."*

However, if I see that the knees are medial to the feet I add, *"Try to keep your knees either over or outside the feet"*, and this is to minimize a valgus strain on the knees and maximize hip external rotation at the same time.



Really Personal Information

For the past 7 years, my family and I have been using a Squatty Potty for toileting. It is simply a 9ö high, curved foot stool that goes under the feet that increases hip flexion during toileting, the way it is supposed to be.

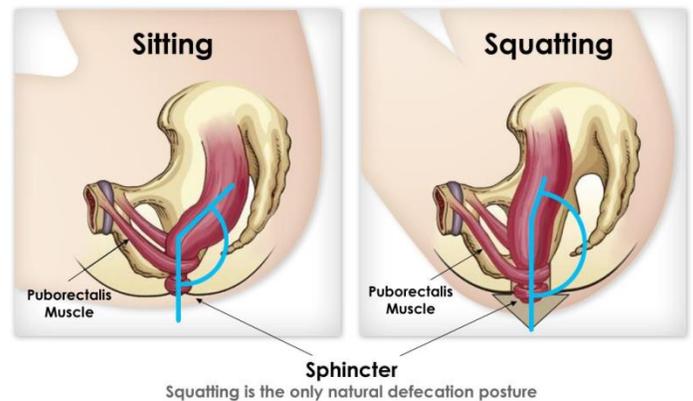


There is actually a study out of Singapore supporting the squat method of toileting over the seated position. They showed that compared to the Western sitting posture, defecation in the squatting posture, required less than half the time and significantly less perceived strain (Sikirov et al 2003).



Instead of spending your valuable time defecating, you may halve the time required for every bowel movement by simply squatting. Perhaps with this simple diagram clearly illustrating the anorectal angle in sitting versus squatting will convince you that I may not be as crazy as I sound.

Anorectal Angle



Please note that I am no way financially linked to Squatty Potty. It got popularized since it got endorsed by Dr. Oz and on Shark Tank. If you decide to get the Squatty Potty, make sure it is the 9ö and not the 7ö as it is too low.

In summary, If you decide squatting on the toilet is not for you, then do your body a favour, feed your lower extremity joints the synovial fluid they crave, and flex your hips and knees past 90° outside of the bathroom. Short periods of daily unloaded deep squats may reduce the risk of development and the progression of hip and knee OA and help maintain lower extremity muscle strength. Try to squeeze in a few deep squats a day for yourself and advise your patients to do it. The evidence supports it!

If you found this paper valuable, please read my rants on “Ice”, “NSAIDs” and “Stretching”. We need to put evidence into practice, instead of just accepting common practices. Articles found on www.aptei.com and please subscribe to the APTEI Reports.

Sincerely, Bahram Jam, PT

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